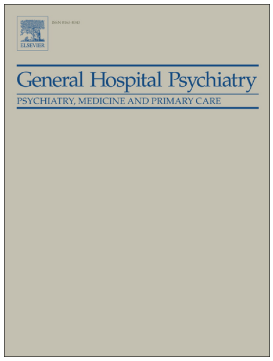

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Prevalence and Predictors of Post-Stroke Mood Disorders: A Meta-analysis and Meta-Regression of Depression, Anxiety and Adjustment disorder

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Summary

Objective

To determine the prevalence and predictors of mood disorders, determined by structured clinical interviews (ICD or DSM criteria) in people after stroke.

Methods

Major electronic databases were searched from inception to June 2015 for studies involving major depression (MDD), minor depression (MnD), dysthymia, adjustment disorder, any depressive disorder (any depressive disorder) and anxiety disorders. Studies were combined using both random and fixed effects meta-analysis and results were stratified as appropriate.

Results

Depression was examined on 147 occasions from 2 days to 7 years after stroke (mean 6.87 months, N=33 in acute, N=43 in rehabilitation and N=69 in the community/ outpatients). Across 128 analyses involving 15,573 patients assessed for major depressive disorder (MDD), the point prevalence of depression was 17.7% (95% CI = 15.6% to 20.0%).65 analyses involving 9720 patients determined MnD was present in 13.1% in all settings (95% CI = 10.9% to 15.8%). Dysthymia was present in 3.1% (95% CI = 2.1% to 5.3%), adjustment disorder in 6.9% (95% CI = 4.6 to 9.7%) and anxiety in 9.8% (95% CI = 5.9% to 14.8%). Any depressive disorder was present in 33.5% (95% CI = 30.3% to 36.8%). The relative risk of any depressive disorder was higher following left (dominant) hemisphere stroke, aphasia, and among people with a family history and past history of mood disorders.

Conclusion

Depression, adjustment disorder and anxiety are common after stroke.Risk factors are aphasia, dominant hemispheric lesions and past personal / family history of depression but not time since stroke.

Conflict of Interest: none to declare

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Introduction

Although standardised age rates of stroke mortality are decreasing across the world, the global burden of stroke (including years lived with disability) are substantial and continuing to increase.[1] Improvements in medical treatment have increased the number of people surviving and living with the consequences of stroke.[2] Depression is particularly problematic and persistent after stroke, with high risk of relapse, even after a long period of remission.[3] People with depression after stroke experience greater impairment, including more substantial reductions in activities of daily living, [4 5 6] poorer quality of life[7] and increased mortality,[8 9] compared with non-depressed stroke patients. Untreated post-stroke depression often impairs physical rehabilitation and recovery.[10 11 12] Depression has also been proposed to have a bidirectional relationship with stroke, being cause by stroke and also acting as a risk factor for stroke itself.[13] Despite the clear importance of depression after stroke, there is evidence suggesting it is under-recognised. [14]

Beyond depression, other mood disorders have been much less extensively investigated. For example, the proportion suffering dysthymia, anxiety disorders or adjustment disorder is essentially unknown. Further to this, although there has been considerable interest in risk factors for post-stroke depression the most commonly investigated factors, namely aphasia and lesion location, remain controversial. Four previous systematic reviews or meta-analyses have examined the importance of lesion location with varying results.[15 16 17 **18**] All these reviews included heterogeneous types of depression, defined by self-report scales alone as well as robust interviews. Indeed despite many narrative reviews of post-stroke depression, none have focussed on robust interview based studies.[19] Two previous meta-analyses also considered the prevalence of depression post stroke, but did not confine the studies included based on robust interviews and were not able to investigate the prevalence of other mood disorders that may also be problematic post stroke (e.g. dysthymia, anxiety disorders or adjustment disorder).[20 21] One recent meta-analysis looked at anxiety disorders with similar limitations.[22] An unresolved question is whether mood disorders remain elevated during rehabilitation and discharge back to the community. If rates of depression and anxiety remain high then clinicians should continue to monitor such patients long after their inpatient treatment has concluded. We therefore set out to address the shortcomings in the literature and establish the

prevalence of mood disorders (major depression, minor depression, dysthymia) as well as adjustment disorder, anxiety disorders and combined mood disorders post stroke. We also set out to examine the underlying influences upon depression by stratifying studies by setting, aphasia, lesion location, family history, personal history and time since stroke.

Methods

This review was conducted in accordance with the Meta-analysis of Observational Studies in Epidemiology (MOOSE)[23] guidelines and with reference to the preferred items for reporting systematic reviews and meta-analysis (PRISMA) statement[24] following a predetermined protocol available on request (PRISMA criteria #5). . MOOSE and PRISMA compliance checklists are available in appendix 3 and 4.

Eligibility criteria

Studies were included that 1) reported the prevalence of depression and related mood or anxiety disorders in adults who had experience a stroke within a consecutive, random or convenience sample on at least one occasion according to the definitions within the ICD or DSM criteria (typically two weeks). This included cross sectional and longitudinal studies. 2) Determined the presence of depression, mood and anxiety disorders through robust interview including structured, semi-structured or a clinical interview applied by a researcher, trained clinician or health professional. 3) Were conducted in acute (inpatient hospital) care, rehabilitation and in the community. Unless predefined by authors, we defined acute care as 0-1 months, in accord with typical length of stays after stroke of 14-21 days.[25 26] Stroke itself was defined by ICD160–169 (non-traumatic intracranial hemorrhage, cerebral infarctions and occlusion and stenosis of cerebral or pre-cerebral vessels without infarction). We considered the following disorders meeting the following DSM research criteria: A. Major depressive disorder (MDD) defined by interview against DSM (III,IIIR,IV) criteria. B. Minor depressive disorder (MnD) as listed in DSM (III,IIIR,IV,IV-TR) under Depressive Disorder Not Otherwise Specified). C. Dysthymia according to DSM (III,IIIR,IV) research criteria. D. Adjustment disorder (either alone or comorbid) by DSM (III,IV) research criteria E. Any depressive disorder , that is syndromal (clinical) depression defined by formal interview and including at least two subtypes of depression defined in DSM (III,IIIR,IV,IV-TR) research criteria F. Anxiety disorders (generalized

anxiety disorder was examined by all such studies but a minority also considered agoraphobia, panic disorder, agoraphobia, OCD and social phobia) by DSM (III,IIIR,IV) criteria.G. Mood comorbidity that is a combination of depression and anxiety with or without adjustment disorder.

Studies were excluded that a) relied upon self-report or observer scales to quantify depression including those using a two-step procedure of an initial scale and then interview in those who screen positive in step 1. b) Were not representative of the general stroke population including those among selected samples (e.g. from interventional trials or those below the age of 18). c) Studies only reporting lifetime prevalence of mood disorder. We also excluded duplicate publications; that is two or more studies on the same sample collected at the same time point. However we allowed multiple analyses by time from one publication (for example assessment at 1, 3 and 12 months). However, we performed restrictor moderator analysis in order to address the influence of this, counting only unique individuals. We did not place any language restriction upon eligible studies. We refer to the period prevalence (for example the last two weeks) hereafter simply as “prevalence”.

Literature search

Two independent authors (AJM, NM) conducted searches of Medline (Pubmed), PsycINFO and Web of Knowledge from inception to June 2015. We used the key words (stroke or cerebrovascular or hemorrhage or cerebral infarctions) and (depression, major depression, major depressive disorder, minor depressive disorder, dysthymia, adjustment disorder, anxiety, panic, generalized anxiety, social anxiety, phobia, mood and emotion$). In addition, we conducted hand searches of the references lists of included articles and contacted numerous International experts to ensure completeness of data acquisition. This was supplemented by online searches of key journals (American Journal of Psychiatry, Neurology, JNNP, Stroke, American Journal of Geriatric Psychiatry, British Journal of Psychiatry). Where possible we reviewed the full text version. For qualifying studies wherever possible we attempted to acquire the required data directly from the primary authors of included studies. The search strategy is shown in appendix 1.

Quality assessment and Risk of bias assessment

Two authors (JSG, AJM) conducted the risk of bias assessment using a four point quality rating and a five point bias risk was applied to each study as used in a recent similar prevalence study.[27] The quality rating score was based on study sample size, study design, study attrition, follow-up (if any) and method of dealing with possible confounders with the following scale: 1 = low quality 2 = low-medium quality 3 = medium – high quality 4 = high quality. The bias rating score evaluated possible bias in assessments of results as influenced by consideration of setting, aphasia, interview method and sampling method. Bias was rated with the following score: 0 = no appreciable bias risk 1 = low bias risk 2 = low to medium bias risk 3= medium to high bias risk 4 = high bias risk. Finally the sampling method was evaluated for each study, as this influences the interpretation of prevalence data (see below). Any area of disagreement was resolved by two supervisors (AJM, NM).

Data extraction

Three independent authors (JG, BS, AJM) conducted all data extraction using a standard extraction form. The data extracted included study design, setting, participant characteristics (number, mean age, gender, details of any cognitive assessment e.g. Mini-Mental State Examination (MMSE)), type of mood disorder and classification criteria used, details of stroke, (including time since the event, type and hemispheric laterality) the prevalence of aphasia and family and personal history of mood disorders studies.

Statistical Analysis

Prevalence and relative risk meta-analyses were calculated. Heterogeneity was defined by I^2 statistic Which describes the percentage of variation across studies that is due to heterogeneity rather than chance and does not inherently depend upon the number of studies considered (Higgins et al., 2003).[28] Due to the moderate and high inconsistency/ heterogeneity (I^2 of ≥80% = moderate ≥90% = high respectively) data was pooled using DerSimonian-Laird random effects meta-analysis with StatsDirect (version 2.7.7). In order to assess for publication bias we conducted the Harbord bias test.[29] Harbord test maintains the power of the Egger test whilst reducing the false positive rate.

In assessing the association between linear variables we used spearman correlation with adjusted R^2. Regarding predictors and correlates of mood disorder we stratified sub analysis and meta-regression. We examined the effect of age, gender, setting, stroke type and time since stroke. The failsafe

number of studies that would justify meta-analysis in any subsection, was set at three, according to convention of the Cochrane collaboration. A meta-regression was conducted for the effect of time since stroke on prevalence using Restricted Maximum Likelihood (REML) estimate of between study variance explained by time with Knapp-Hartung modification for small samples

Results

The initial searches yielded 2658 hits on pubmed, 1,168 hits on Web of Knowledge and 883 on PsychINFO (1833 after removal of duplicates) but upon review only 419 were relevant after initial screening (see PRISMA flowchart appendix 2). From 419 articles reviewed in detail following application of the eligibility criteria: a total of 108 publications were included that examined the prevalence of depression among 14,220 unique patients who had experienced a stroke (references of included articles are presented in appendix 5). Details of the search strategy and breakdown of the study characteristics are summarized in figure 1. Considering each assessment in time as separate analysis meant that depression was examined on 147 occasions from 2 days to 7 years after stroke (mean 6.87 months) across the studies.

Insert figure 1 here

Study and participant characteristics

Of 147 included analyses (in 108 publications), 33 took place in an acute hospital setting, 43 in rehabilitation settings and 69 in the community or hospital outpatient settings (see appendix table 2 for full details). The mean age of stroke patients across all studies was 65.0 years, and 43.8% were female. 42 studies conducted the MMSE in their sample and the mean MMSE score among 5539 patients was 25.8. Of the included studies, 16 offered prospective assessment of depression at least two points after stroke. 128 analyses reported on the prevalence estimates of major depression (n=15,573), 65 on minor depression (n=9720), 75 on major or minor depression combined (n=10,799), 25 reported rate of anxiety disorders (n=2974), largely mixed types or generalized anxiety disorder), and 18 reported rates of dysthymia (n= 3320), and 8 reported on adjustment disorder (n= 1849). A subset of analyses looked at regional stroke location, most commonly hemisphere laterality (N=44, n=6115). 55 analyses considered only cerebral ischaemic stroke (n=7386), the remainder considered mixed types of stroke. Of studies reporting types of stroke approximately 83% had ischaemic thromboembolic stroke. 95 analyses assessed and excluded people with aphasia and only 5 studies specifically reported on the prevalence of depression in stroke patients with aphasia. Full details of each study are presented in online appendix table 2.

Quality assessment of the included studies is summarized in online appendix 2. 24.1% of studies had a low quality. The most common reasons for low quality were using an unstructured clinical interview, not fully reporting data and low sample size. Regarding risk of bias, 13% of studies had a high risk of bias. The most common risk identified among the studies included not reporting blinding of assessments, using single stroke types, not reporting pre-defined cut-offs for diagnostic thresholds, and a lack of information concerning drop outs.

Overall pooled prevalence of any disorder of mood or emotion

The overall pooled prevalence of *any disorder of mood or emotion* across all settings was 27.0% (95% CI = 21.8% to 32.3%). The pooled prevalence of *any disorder of mood or emotion* was 31.6% (95% CI = 20.6% to 43.7%), 25.4% (95% CI = 17.8% to 33.7%) and 26.7% (95% CI = 19.0% to 35.2%) in acute, rehabilitation and community settings respectively. The pooled prevalence of each disorder are summarized in table 1.

Insert table 1 here

Prevalence of Depression

1. *DSM Major Depression*

In total, the pooled prevalence of MDD across 128 analyses (n=15,573) measured a mean of 6.9 months after stroke, was 17.7% (95% CI = 15.6% to 20.0%,). There was evidence of publication bias in this sample with a lower than expected number of small studies showing a small proportion with depression (p = 0.01). The prevalence of MDD among studies including people with aphasia was 14.3% (95% CI = 11.1% to 17.8%) and 19.9% (95% CI = 17.3% to 22.6%) in those analyses with aphasia excluded. When restricted to a non-overlapping sample of 12,723 unique individuals in 98 studies, then the prevalence was 19.2% (95% CI = 16.6% to 22.0%).

It was possible to pool 32 analyses (n=3838) examining MDD in the acute post-stroke period, a mean of 3.4 weeks after stroke. This established a pooled prevalence of post-stroke MDD of 18.1% (95% CI = 14.4% to 22.1%) (figure 2). Sub group analysis revealed that this estimate was not statistically different in studies that included or excluded aphasic patients or restricting the analyses to non-overlapping samples of unique individuals. Next, we pooled 42 analyses (n=3444) examining MDD in rehabilitation settings, a mean of 7.1 months after stroke. The prevalence of post-stroke MDD was

20.0% (95% CI = 16.3% to 24.1%). It was 17.8% (95% CI = 12.8% to 23.4%) in those studies with aphasia included and 21.4% (95% CI = 16.3% to 26.9%) in those analyses with aphasia excluded. Results were almost identical when restricted to non-overlapping sample. Full details of the analysis are displayed in table 1.

Insert figure 2 here

56 analyses (n=8557) examined MDD in a patients in community settings, a mean of 10.0 months after stroke. The point prevalence of depression was 15.8% (95% CI = 12.7% to 19.2%). The pooled prevalence of MDD was 12.4% (95% CI = 8.7% to 16.7%) in those studies with aphasia included and 18.7% (95% CI = 14.6% to 23.3%) in those analyses with aphasia excluded. When restricted to a non-overlapping sample of 5960 unique individuals) the prevalence was 18.0% (95% CI = 13.1% to 23.4%).

2. DSM Minor Depression

In total 65 analyses (n=9720) examined MnD across all settings establishing a prevalence of 13.2% (95% CI = 10.9% to 15.8%). This was 12.6% (95% CI = 10.2% to 15.2%) in those without aphasia and 15.7% (95% CI = 10.2% to 22.1%) in those that did not exclude aphasia. 18 analyses (n=2386) examined MnD in an acute hospital setting, a mean of 3.4 weeks after stroke. The prevalence of post-stroke MnD was 10.9% (95% CI = 7.4% to 14.9%). Further details of subgroup analysis according to the setting are presented in table 1.

Anxiety disorder

The pooled prevalence of anxiety disorder across all settings (N=25, n=2974) was 9.8% (95% CI = 5.9% to 14.8%). The pooled prevalence in acute setting was 10.7% (95% CI = 3.8% to 20.4%), whilst 7.0% (95% CI = 3.4% to 11.7%) and 12.8% had anxiety in rehabilitation and community setting respectively.

Adjustment disorder

The pooled prevalence of adjustment disorder was calculated from 8 analysis (n=1849) across all settings at 6.9% (95% CI = 4.6% to 9.7%). Due to limited data it was not possible to conduct subgroup analysis among people with adjustment disorder across different settings.

Dysthymia

The pooled prevalence of dysthymia across all settings was 3.6%. The pooled prevalence was highest in acute settings (8.4%, 95% CI = 1.59% to 19.9), followed by rehabilitation (5.1%, 95% CI=1.73% to 10.1) and community settings (2.3%, 95% CI= 1.1-3.9%).

Predictors of Post-Stroke Depression

1. *The Effect of Hemispheric Laterality*

In patients with a stroke affecting the left hemisphere (across all time periods and settings) (N=19, n=1887) MDD was present in 34.3% (95% CI = 24.8% to 44.4%). This was significantly higher than the rate of MDD after stroke irrespective of lesion site (17.7%, 95% CI = 15.6% to 20.0%, see above). A relative risk analysis of MDD after left hemisphere lesions vs MDD after non-left hemisphere lesions was conducted and had no evidence publication bias or hetergeneity (figure 3). Given the low heterogeneity a fixed effects meta-analysis showed that the risk of MDD was 1.50 (95% CI = 1.29 to 1.74, $Chi^2 = 27.4$, $P < 0.0001$) following left vs non-left lesions. This effect was also significant using random effects meta-analysis (data not shown).

Insert figure 3 about here

20 analyses involving 3618 patients examined whether the prevalence of any depressive disorder was influenced by hemishpere laterality. In those with a left hemisphere stroke the rate of any depressive disorder was 41.1% (95% CI = 37.4% to 44.8%). This was significantly higher than the rate of any depressive disorder depression after stroke irrespective of lesion site (33.5% (95% CI = 30.3% to 36.8% see above). A relative risk analysis of any depressive disorder after left hemisphere lesions vs depression after non-left hemisphere lesions was conducted and had no evidence publication bias or hetergeneity. On fixed effects meta-analysis the risk of any depressive disorder

was 1.26 (95% CI = 1.16 to 1.37, Chi^2 = 27.4, P < 0.0001) following left vs non-left lesions. This effect remained statistically significant using random effects meta-analysis (data not shown).

2. The Effect of Aphasia

Only four analysis involving 113 patients examined MDD in stroke patients with clearly defined aphasia (all settings and all time periods) were available and the pooled prevalence of MDD in aphasic patients was 30.5% (95% CI = 10.1% to 56.1%). There was insufficient data to perform a relative risk analysis because only two studies reported on the rate of depression in stroke patients with vs without aphasia in their sample.

Only five analysis involving 211 patients examined any depressive disorder in stroke patients with aphasia (all settings and all time periods). The prevalence of any depressive disorder in aphasic patients was 52.2% (95% CI = 34.9% to 69.3%) There was a 50% increased risk of depression in stroke patients with vs without aphasia (RR 1.50, 95% CI = 1.28 to 1.75).

3. The Effect of Family History of Mood Disorders

Eight studies involving 1099 patients examined the influence of family history on the prevalence of depression after stroke. In those with a family history there was a 27.3% rate (95% CI = 17.4% to 38.5%) of any depressive disorder vs 20.0% (95% CI = 13.2% to 27.6%) in those without a family history. The relative risk of depression was 1.44 (95% CI = 1.15 to 1.80).

4. The Effect of Past History of Mood Disorders

Eight studies involving 1058 patients examined the influence of family history on the prevalence of depression after stroke. In those with a past history there was a 22.4% (95% CI = 15.2% to 30.5%) of any depressive disorder vs 12.8% (95% CI = 9.9% to 16.1%) in those without a personal past history. The relative risk of depression was 1.80 (95% CI = 1.36 to 2.38).

5. The Effect of Time Since Stroke

The most frequent occasion after stroke when depression was measured was 12 months, when the prevalence of MDD was 13.4% (95% CI = 9.6% to 17.8%) and the prevalence of any depressive disorder was 23.9% (95% CI = 18.5% to 29.8%). We conducted a meta-regression concerning the

effect of time since stroke on the prevalence of depression (figure 4) and anxiety (figure 5). Looking at MDD there was a non-significant decrease in prevalence of depression by time (coefficient = -0.01; t=-1.30 p=0.196). There were similar findings for any depressive disorder MnD and anxiety.

Insert figure 4 and 5 here

Discussion

To our knowledge, this is the first study to examine the prevalence and predictors of post-stroke depression / anxiety / adjustment disorder using meta-analysis solely based upon interview defined clinical disorders. Across 128 analyses of post-stroke major depression, the point prevalence of depression was 17.7% (95% CI = 15.6% to 20.0%) although this was 19.2% when restricted to unique sample of 12,723 individuals in 98 non-overlapping studies. Results were broadly equivalent in different settings, varying from 15.8% in community/outpatient settings and 20.0% in rehabilitation settings. These prevalence estimates are similar to the rates of major depression defined by interview in large scale meta-analyses in primary care (17·3%, 12·2% to 23·1%)[30] and cancer (14·9%, 12·2–17·7%).[31] However, it is important to recognise major depression is only one of several important mood disorders. Minor depression and other non-major depressions are associated with significant burden [32] and previous meta-analyses have failed to consider the range of mood disorders. We found 65 analyses involving 9720 patients that examined MnD, across all settings and found that MnD was present in 13.1% (13.3% in unique patient analysis) although it was particularly high as 16.7% in rehabilitation settings. An additional 3.1% had dysthymia and 6.9% had adjustment disorder. Overall we estimate that at least one in three have clinical depression (any depressive disorder) on any particular day after stroke. The clinical implication is that clinicians should be vigilant for depression after stroke and further routine screening may be worth considering. This is comparable to previous meta-analyses that have not confined their results to robust interview defined clinical disorders.[20 21] One recent meta-analysis examined anxiety disorders but included mixed scales and only 8 studies involved objective methods. We expand upon this to involve 25 studies of anxiety disorders.[22] When examined cross-sectionally, at precisely 12 months, we found that 13.5% had MDD and 23.9% any depressive disorder using pooled data. The clinical implication is that even a year after stroke, depression is significant. Future research should investigate the long-term burden of depression on patients and families.

Relatively few studies have examined anxiety disorders using interview methods. Of those, the prevalence of anxiety disorders was 9.9% (95% CI = 5.9% to 14.8%) with no clear difference in particular settings but 11.7% in a re-analysis using a non-overlapping sample. This is quite likely to be an underestimate, in part because not all studies measure all types of anxiety disorder, partially

because depressive disorders receive most clinical attention and partially because criteria for GAD are currently very restrictive, requiring at least 6 months duration (note that some authors have purposely omitted this).[33] Unfortunately, the clinical significance of anxiety disorders after stroke, for example effect on daily function, effect on long-term recovery and interaction with major depression remains under studied. Once combined, the prevalence of *any disorder of mood or emotion* appears to be at least 30% although this is not a case of simple addition of the aforementioned categories because many types of mood disorder are comorbid. Future research should investigate not just the prevalence but also the impact of anxiety on rehabilitation and mortality.

We were only able to study possible risk factors for MDD, any depressive disorder and anxiety after stroke. There was insufficient data to study disease burden which appears influential according to previous research.[34 35 36] The relative risk of MDD was 50% higher (RR=1.50, 95% CI = 1.29 to 1.74) and the relative risk of any depressive disorder was 26% higher (RR=1.26, 95% CI = 1.16 to 1.37) following left (dominant) hemisphere stroke. Lesions in the dominant hemisphere generally cause more disability and a high chance of communication difficulties. Perhaps unsurprisingly therefore, the relative risk of any depressive disorder was 50% higher following aphasia (RR = 1.50, 95% CI = 1.28 to 1.75). The prevalence of MDD was higher in aphasic vs non- aphasic patients was 30.5% vs 19.9% but this did not reach statistical significance. Two other risk factors appeared to be important for post-stroke depression. The relative risk of any depressive disorder was 1.44 (95% CI = 1.15 to 1.80) if there was a family history of mood disorders and 1.80 (95% CI = 1.36 to 2.38) if there was a prior history of mood disorder. Regarding the effect of time since stroke, this was suprisingly weak. There was a non-significant decrease in prevalence of MDD by time (t=-1.30 p=0.196). A similar non-significant decrease was found for any depressive disorder, MnD and anxiety. Several other groups have examined the predictors of post-stroke depression using self-report depression scales. White et al (2011) found that the prevalence of depression in 2,477 participants at 4 months after stroke was 19%[37] and contrary to our results, they found that risk of depression reduced by duration post-stroke. The clinical implication is that left (dominant) hemisphere stroke, aphasia, personal history and family history of mood disorders are the predominant known risk factors. Time since stroke is a weak risk factor and as such a high index of suspicions should be maintained even 5 years after a stroke, particularly where neurological complications persist.

We acknowledge the following limitations, which are largely accounted for by limitations in the primary studies. Despite the large sample size there were inadequate data in some subgroups and in some mood disorders, particularly adjustment disorders. There was also inadequate data to examine several potentially useful predictors of mood disorders such as disability, gender and quality of life and receipt of antidepressants; these should ideally be addressed in future studies. We acknowledge considerable heterogeneity in the sample and occasional evidence of publication bias (see table 1). There were variations in the handling of aphasia, although we attempted to allow for this by clarifying if studies included or excluded patients with communication difficulties. Few studies attempted to quantify severity of dysphasia and only nine studies (4 MDD 5 any depressive disorder) specifically reported on prevalence in aphasic patients. It is possible that aphasia reduces the ability to perform structured interviews, reducing recruitment and possibly leading clinicians to rely on somatic symptoms such as agitation or retardation. A further limitation concerned the definition of mood disorders. Although we focussed on interview based definition using a structured, semi-structured or a clinical interview there was still considerable variation in type and quality of this interview. This could have introduced variations in prevalence according to the assessment method. Further almost all studies examined point prevalence, meaning that transitions in to and out of remission were poorly described as were the total number of cases developing over a period of time (cumulative prevalence). We also note that stroke patients often have a high burden of physical symptoms and symptoms such as fatigue, anorexia and psychomotor retardation which may be caused by stroke or alternatively by depression. As such the phenomenology of post-stroke depression may be different to non-comorbid depression. That said most studies have found only minor differences in presentation.[38] [39] . Finally, we only searched three electronic databases.

We conclude post-stroke *disorders of mood or emotion* appear to be common and highly comorbid. Prevalence estimates do not appear to vary significantly with time but are typically higher in rehabilitation settings than in community settings. The key risk factors for post-stroke depression appear to be a past history of depression, a family history of depression, aphasia and left hemisphere lesions. Contrary to some previous reviews,[15] [16] [17] [18] this more thorough quantitative analysis shows that lesion location is important for post-stroke depression but it is only one of many risk factors. The

UK National Clinical Guidelines for Stroke recommend screening for depression within the first month of a stroke event; however, compliance with this is inconsistent.[40] Given the persistent nature of post-stroke mood disorders we recommend clinical assessment and routine screening is extended to one year. We also recommend clinicians look for broadly defined mood disorders, anxiety and distress, not just major depression alone.

Appendix 1 Search strategy (including search terms)

Appendix 2 PRISMA flowchart

Appendix 3 Moose Checklist

Appendix 4 Prisma Checklist

Appendix 5 Qualifying study list

Summary Table 1 – Statistical Summary of the Prevalence of Mood and Anxiety Disorders after Stroke by Setting

		Acute Hospital	Rehabilitation	Community / Outpatient	Overall (all settings)
Major Depression (DSM)	**Prevalence (CI)**	18.1% (95% CI = 14.4% to 22.1%)	20.0% (95% CI = 16.3% to 24.1%)	15.8% (95% CI = 12.7% to 19.2%)	17.7% (95% CI = 15.6% to 20.0%)
	Inconsistency	89.1% (95% CI = 86.1% to 91.2%)	87.9% (95% CI = 85.0% to 90.1%)	94.1% (95% CI = 93.3% to 94.8%)	92.1% (95% CI = 91.3% to 92.8%)
	Harbord bias	-0.12 (92.5% CI = -3.36 to 3.12) P = 0.95	2.52 (92.5% CI = -0.33 to 5.37) P = 0.11	2.70 (92.5% CI = 0.17 to 5.22) P = 0.06	2.27 (92.5% CI = 0.78 to 3.76) **P = 0.01**
Minor Depression (DSM)	**Prevalence (CI)**	10.9% (95% CI = 7.4% to 14.9%)	16.7% (95% CI = 11.1% to 23.3%)	12.6% (95% CI = 9.3% to 16.3%)	13.2% (95% CI = 10.9% to 15.8%)
	Inconsistency	87.8% (95% CI = 82.6% to 90.9%)	92.1% (95% CI = 89.5% to 93.7%)	93.1% (95% CI = 91.4% to 94.2%)	91.9% (95% CI = 90.7% to 92.9%)
	Harbord bias	0.70 (92.5% CI = -2.74 to 4.15) P = 0.70	1.49 (92.5% CI = -4.00 to 6.99) P = 0.61	-2.27 (92.5% CI = -5.82 to 1.27) P = 0.25	-0.37 (92.5% CI = -2.53 to 1.78) P = 0.75
Any Depression (DSM or ICD) (Major or minor or dysthymia	**Prevalence (CI)**	33.9% (95% CI = 29.0% to 39.0%)	43.6% (95% CI = 34.5% to 52.9%)	28.5% (95% CI = 24.7% to 32.5%)	33.5% (95% CI = 30.3% to 36.8%)
	Inconsistency	88.6% (95% CI = 84.9% to 91.1%)	94.9% (95% CI = 93.9% to 95.7%)	93.1% (95% CI = 92% to 94%)	93.6% (95% CI = 92.9% to 94.1%)
	Harbord bias	-0.35 (92.5% CI = -3.61 to 2.92) P = 0.85	2.26 (92.5% CI = -1.90 to 6.43) P = 0.32	0.071 (92.5% CI = -2.80 to 2.94) P = 0.96	1.45 (92.5% CI = -0.38 to 3.29) P = 0.16
Any Anxiety Disorder (DSM or ICD)	**Prevalence (CI)**	10.7% (95% CI = 3.8% to 20.4%)	7.0% (95% CI = 3.4% to 11.7%)	12.8% (95% CI = 11.3% to 14.3%)	9.8% (95% CI = 5.9% to 14.8%)
	Inconsistency	90.7% (95% CI = 70.8% to 95.2%)	74.6% (95% CI = 37.5% to 85.8%)	96.3% (95% CI = 95.3% to 96.9%)	94.4% (95% CI = 93.1% to 95.3%)

	Harbord bias	13.83 (92.5% CI = -42.54 to 70.20) P = 0.29	6.71 (92.5% CI = 2.09 to 11.34) P = 0.02	-5.13 (92.5% CI = -14.24 to 3.97) P = 0.29	-2.22 (92.5% CI = -7.82 to 3.38) P = 0.47
Adjustment Disorder (DSM or ICD)	**Prevalence (CI)**	Insufficient Data	Insufficient Data	Insufficient Data	6.9% (95% CI = 4.6% to 9.7%)
	Inconsistency	Insufficient Data	Insufficient Data	Insufficient Data	72.3% (95% CI = 34.3% to 84.3%)
	Harbord bias	Insufficient Data	Insufficient Data	Insufficient Data	3.41 (92.5% CI = 1.68 to 5.14) P = 0.0045
Dysthymia (DSM or ICD)	**Prevalence (CI)**	8.4% (95% CI = 1.59% to 19.9%)	5.1% (95% CI = 1.73% to 10.1%)	2.3% (95% CI = 1.1% to 3.9%)	3.6% (95% CI = 2.1% to 5.4%)
	Inconsistency	82.2% (95% CI = 0% to 92.4%	69.1% (95% CI = 0% to 85.9%)	79.4% (95% CI = 60.9% to 87.0%)	81.6% (95% CI = 71.7% to 86.9%)
	Harbord bias	10.03 (92.5% CI = -54.53 to 74.59) P = 0.41	5.70 (92.5% CI = 0.39 to 11.01) P = 0.06	3.99 (92.5% CI = 1.33 to 6.64) P = **0.01**	4.89 (92.5% CI = 2.69 to 7.10) P = **0.0006**
Any Mood Disorder (DSM or ICD)	**Prevalence (CI)**	31.6% (95% CI = 20.6% to 43.7%)	25.4% (95% CI = 17.8% to 33.7%)	26.7% (95% CI = 19.0% to 35.2%)	27.0% (95% CI = 21.8% to 32.3%)
	Inconsistency	89.2% (95% CI = 61.3% to 94.7%)	80.5% (95% CI = 60.1% to 88.1%)	94.1% (95% CI = 92% to 95.4%)	91.2% (95% CI = 88.6% to 92.9%)
	Harbord bias	3.64 (92.5% CI = -89.67 to 96.95) P = 0.80	4.43 (92.5% CI = -0.66 to 9.53) P = 0.11	-2.29 (92.5% CI = -10.09 to 5.52) P = 0.58	-0.91 (92.5% CI = -4.65 to 2.84) P = 0.66

Declaration of interest none

Conflicts of interest none

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Alex J Mitchell	none
Bhavisha Sheth	none
John Gill	none
Motahare Yadegarfar	none
Brendon Stubbs	none
Mohammad Yadegarfar	none
Nick Meader	none

C) Contributorship Statement:

Alex J Mitchell	concept, search, extraction, analysis, writing, editing
Bhavisha Sheth	search, extraction
John Gill	search, extraction
Motahare Yadegarfar	search, extraction, analysis
Brendon Stubbs	Search, extraction, writing, editing
Mohammad Yadegarfar	analysis
Nick Meader	concept, search, extraction, editing

Figure 1 – Quorum figure of study count

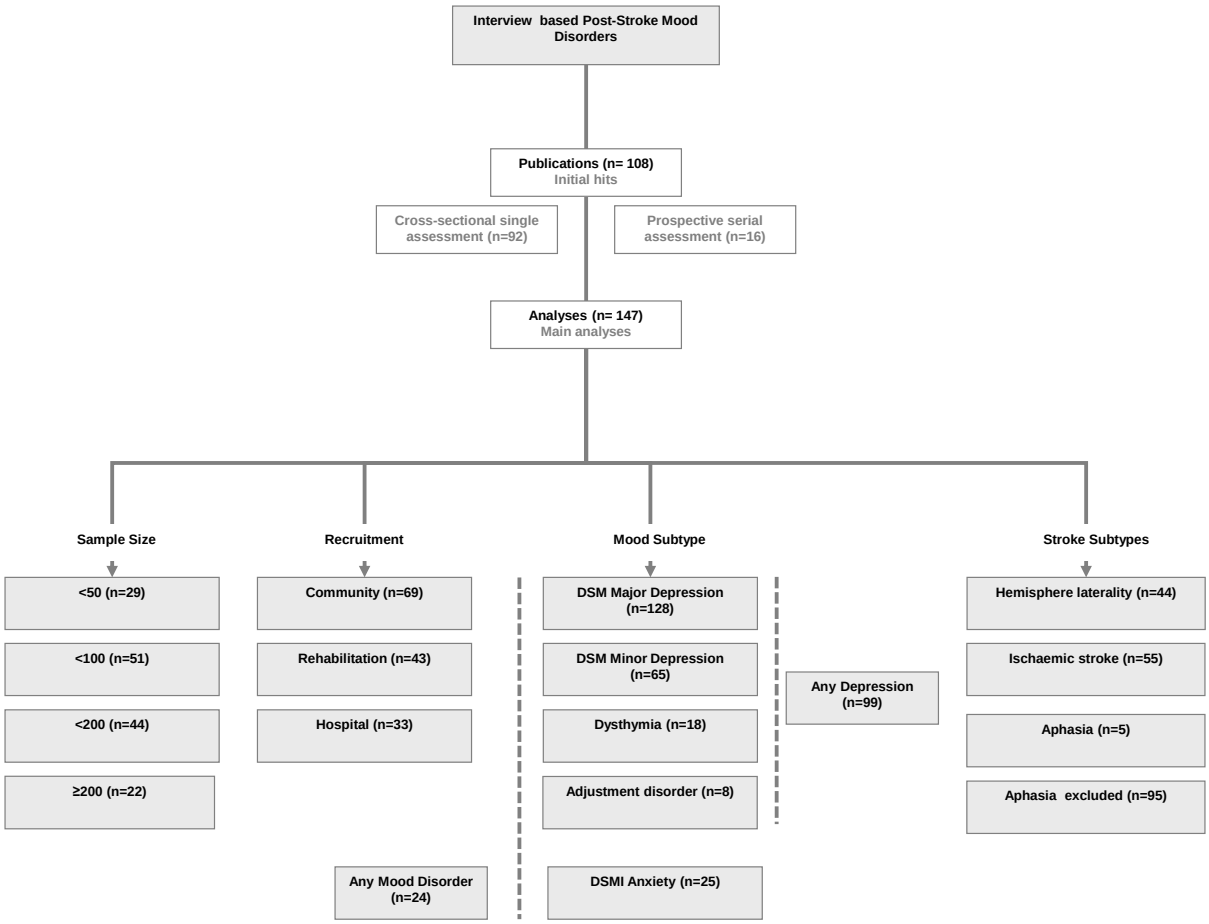


Figure 2 – Prevalence of Post-Stroke Depression in Acute Settings

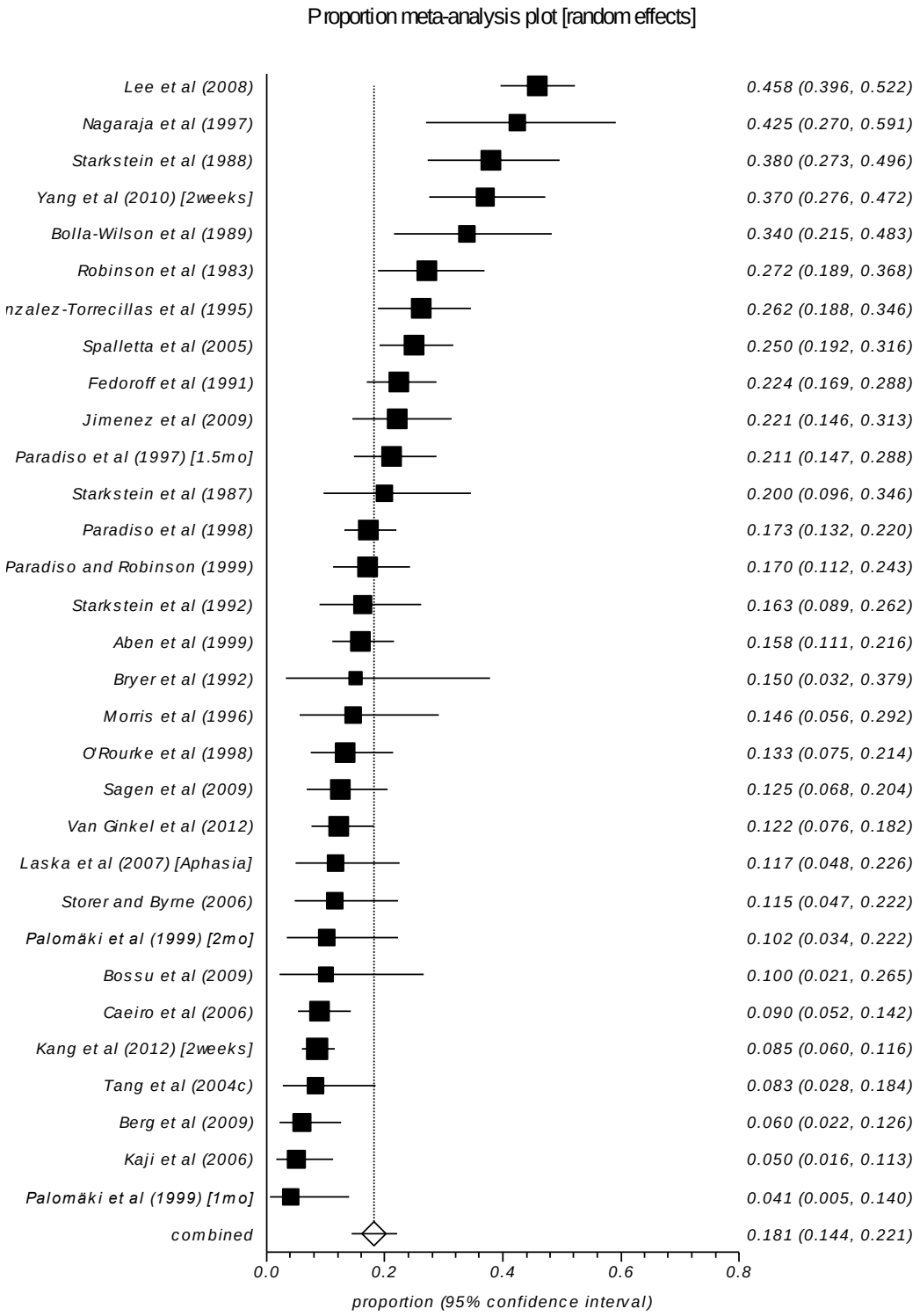


Figure 3 – Relative Risk of Major Depression after left hemisphere stroke

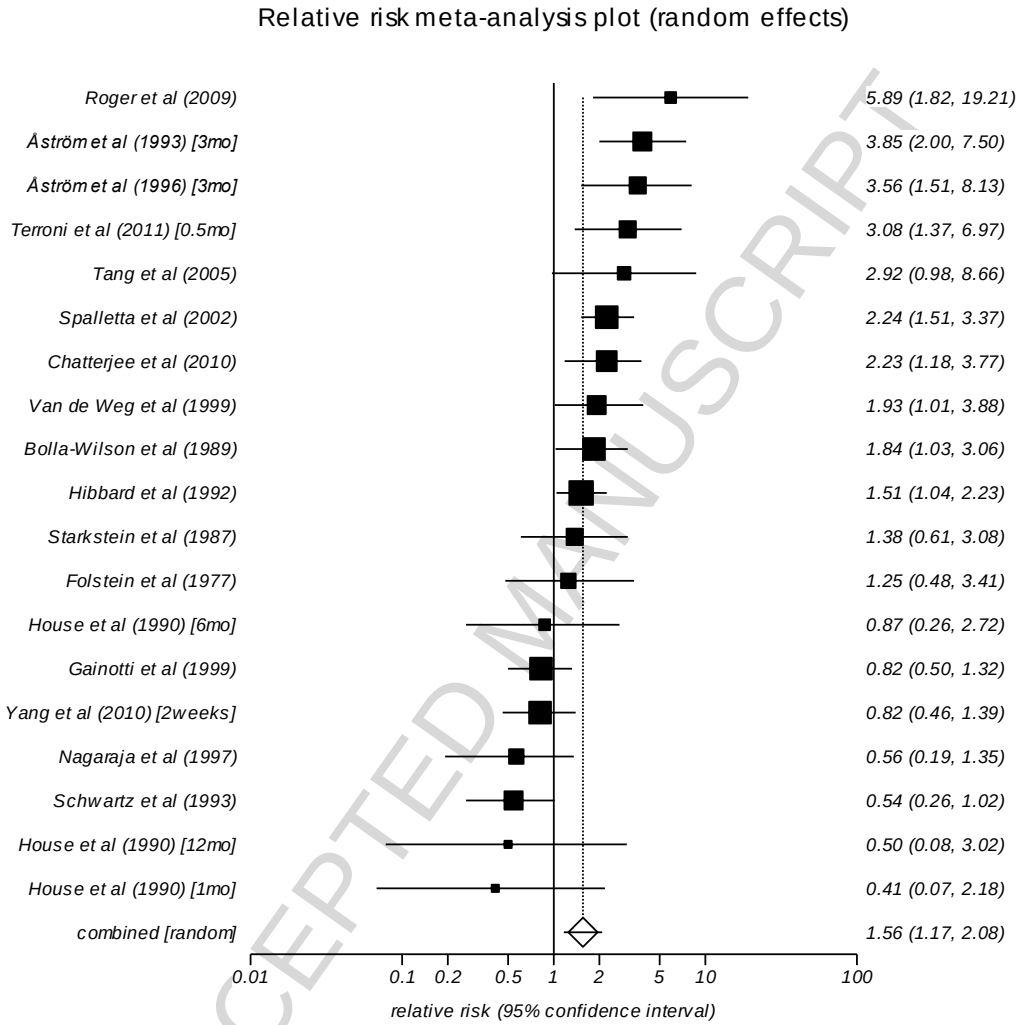
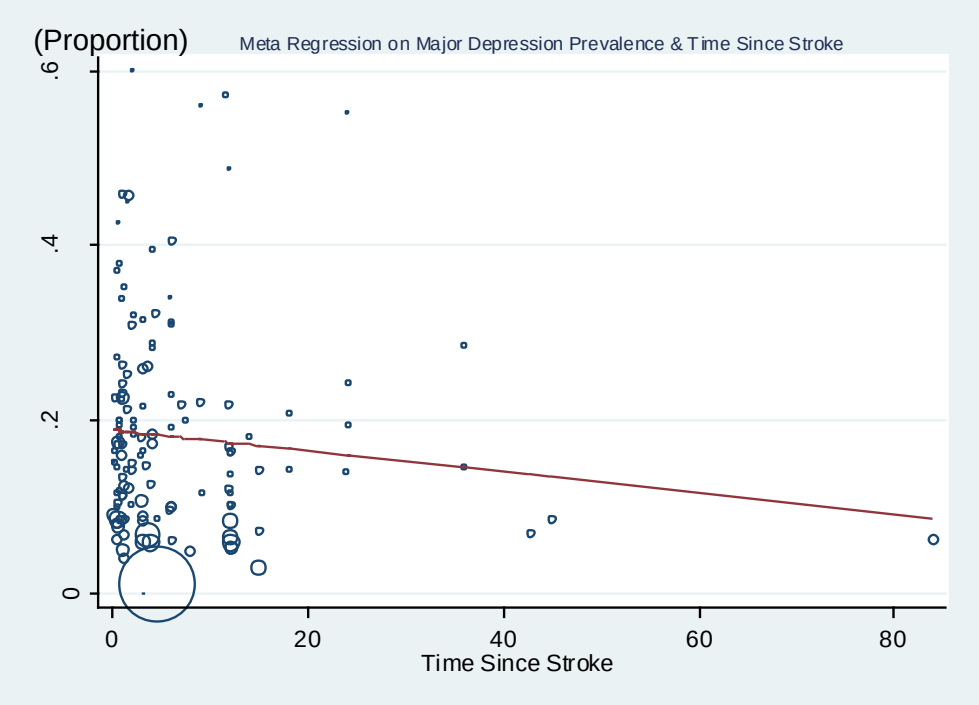


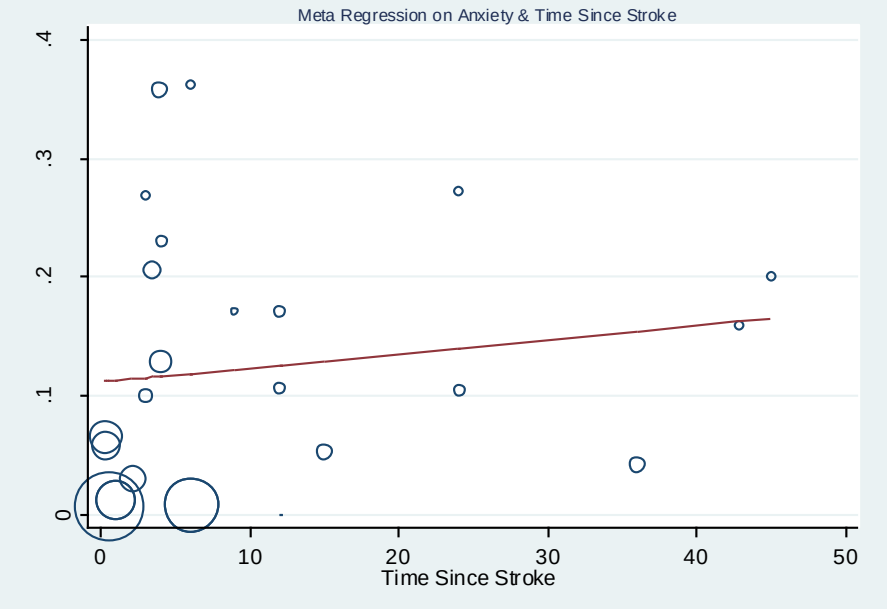
Figure 4 – Meta-regression: major depression prevalence estimate and time since stroke (in months)



(months)

Figure 5 – Meta-regression on anxiety prevalence estimate and time since stroke in months

(Proportion)



ıe since stro

(months)

Table 2

Author	New quality rating score	New bias rating score	Year	Aphasia excluded	Total sample with Stroke	Age (Mean).	Setting	Method of defining depression	Operational criteria	Gender (Female %)	Country
Aben et al (1999)	4	1	2002	Y	202	68.5	Hospital inpatients	SCID	DSMIV MDD+MnD	45.50%	Netherlands
Aben et al (2002)	4	1	2002	Y	190	68.6	Hospital Outpatients	SCID	DSMIV MDD+MnD	46.80%	Netherlands
Aben et al (2006)	4	1	2006	Y	189	68.6	Hospital Outpatients	SCID	DSMIV MDD+MnD	47%	Netherlands
Agrell and Dehlin (1994)	3	1	1994	Y	93	76.5	Geriatric rehabilitation clinic	SCID	DSMIIIR MDD+MnD	42%	Sweden
Agrell et al (1989)	2	3	1989	Y	40	80	outpatient, rehabilitation, nursing home	Unstructured Clinical Interview	DSMIIIR MDD+MD	55%	Sweden
Altieri et al (2012)	4	1	2012	Y	105	64.4	Stroke rehabilitation unit in hospital	SCID	DSMIV MDD+MnD	34%	Italy
Appelros et al (2004)	3	1	2004	N	251	74.5	Hospital Outpatients	SCID	DSMIV MDD+MnD	50.90%	Sweden
Åström et al (1993)	4	1	1993	N	73	73	Hospital Outpatients	Psychiatric diagnostic interview	DSMIII MDD	39%	Sweden
Åström et al (1996)	4	1	1996	N	70	73	Stroke rehabilitation unit in hospital	SCID	DSMIIIR MDD	39%	Sweden
Berg et al (2009)	2	3	2009	N	100	55	Hospital inpatients	Unstructured Clinical Interview	DSMIIIR MDD	32%	Finland
Bolla-Wilson et al (1989)	3	1	1989	Y	53	59.6	Acute	Present State Examination	DSMIII MDD	NR	US
Bossu et al (2009)	2	2	2009	N	30	66.43	Inpatient stroke unit	Research Diagnostic criteria (RDC)	DSMIVTR MDD+MnD	47%	Italy
Bour et al (2010)	4	1	2010	Y	138	66.1	Hospital Outpatients	SCID	DSMIV MDD+MnD	48%	Netherlands
Brodaty et al (2007)	4	1	2007	Y	135	72.01	Community follow-up from Inpatient stroke unit	SCID	DSMIV MDD+MnD	43%	Australia
Bryer et al (1992)	2	2	1992	Y	20	55.3	Hospital inpatients	Present State Examination	DSMIII MDD+MnD	50%	USA
Burvill et al (1995)	4	1	1995	Y	294	72	Community	Present State Examination	DSMIII GAD Agoraphobia	44%	Australia
Burvill et al (1995)	4	1	1995	Y	248	72	Community	Present State Examination	DSMIII MDD+MnD	44%	Australia

Burvill et al (1996)	3	2	1996	Y	117	NR	Community	Psychiatric Assessment Schedule	DSMIII MDD+MnD	42%	Australia
Burvill et al (1997)	3	2	1997	Y	191	NR	Community	Psychiatric Assessment Schedule	DSMIII MDD+MnD	NR	Australia
Caeiro et al (2006)	3	1	2006	N	178	56.8	Hospital inpatients	SCID	DSMIVTR MDD	40%	Portugal
Carota et al (2005)	4	1	2005	N	246	66.4	Stroke rehabilitation unit in hospital	SCID	DSMIV MDD+MnD	47%	Switzerland
Cassidy et al (2004)	3	1	2004	N	50	51.4	Stroke rehabilitation unit in hospital	SCID	DSMIV criteria	42%	Ireland, UK
Castillo et al (1993)	4	1	1993	Y	309	58.9	Hospital inpatients	Present State Examination	DSMIII MDD	43.80%	USA
Castillo et al (1995)	4	1	1995	Y	78	58.2	Hospital Outpatients	Present State Examination	DSMIII MDD	43%	USA
Chatterjee et al (2010)	4	1	2010	Y	182	70	Community	SCID	DSMIV MDD+MnD	NR	UK
Cumming et al (2010)	3	2	2010	N	149	81	Hospital Outpatients	Psychiatric diagnostic interview	DSMIIIR MDD	65%	Sweden, Australia
Dam (2001)	3	1	2001	Y	99	57	Hospital or via telephone	Research Diagnostic criteria (RDC)	DSMIIIR MDD +MnDD	34%	Denmark
Fedoroff et al (1991)	4	1	1991	Y	205	58.7	Hospital inpatients	Present State Examination	DSMIII MDD+MnD	48%	USA
Folstein et al (1977)	2	2	1977	N	20	63.3	Rehabilitation Hospital	Present State Examination (8th Edn)	DSMII	55%	USA
Gainotti et al (1999)	3	1	1999	N	153	62.3	Rehabilitation centre	SCID	DSMIII criteria	42%	Italy
Gonzalez-Torrecillas et al (1995)	4	1	1995	Y	130	67.58	Hospital inpatients	SADS interview	Research Diagnostic criteria (RDC)	53.80%	Spain
Gordon et al (1991)	4	1	1991	Y	116	67.83	Rehabilitation Hospital	SCID	DSMIII MDD+MnD	40.50%	USA
Grasso et al (1994)	2	2	1994	Y	15	67.8	Rehabilitation centre	Psychiatric diagnostic interview	DSMIIIR	53.00%	Italy
Grober et al (1991)	2	2	1991	N	29	66	Outpatient	SCID	DSMIII MDD	NR	USA
Healey et al (2008)	2	2	2008	N	49	55	Inpatient rehabilitation centre	SCID	DSMIV MDD	57.10%	UK
Herrmann et al (1995)	2	2	1995	N	47	62	Stroke rehabilitation unit in hospital	SCID	DSMIIIR MDD +MnDD	34%	Germany
Hibbard et al (1992)	3	1	1992	Y	82	67.1	Inpatient and outpatient rehab programs in 3 New York Hospitals	DSMIIIR diagnosis formulated using Structured Assessment of Depression in Brain-Damaged Individuals	DSMIIIR MDD+MD	54%	USA
House et al (1990)	4	1	1991	N	89	71.2	Community	Present State Examination	DSMIII MDD	55%	UK
House et al (2001)	3	1	2001	Y	448	70.7	Community	Present State Examination	ICD10 criteria	46%	UK
Jimenez et al (2009)	3	1	2009	Y	104	70.4	Stroke unit	SCID	DSMIV MD+MnD	33%	Spain

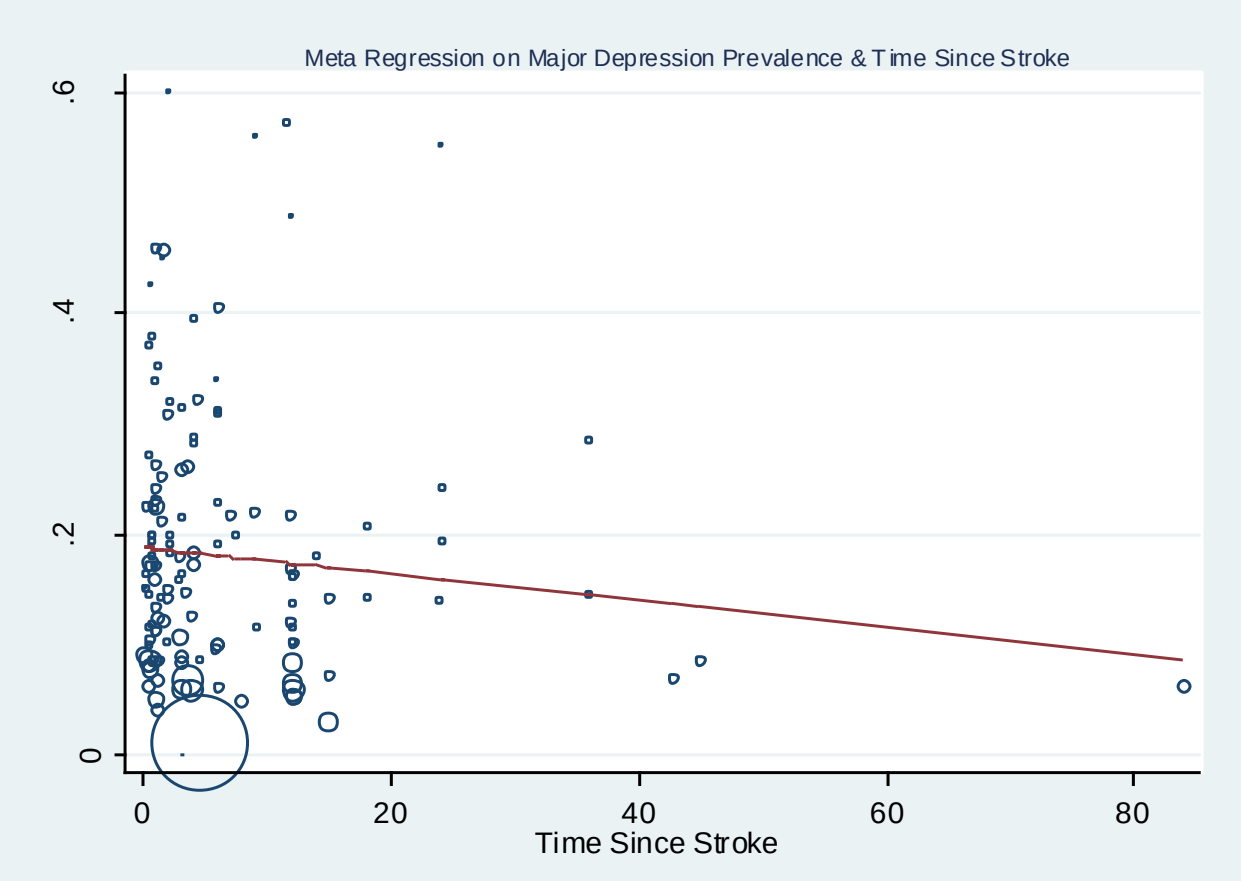
Kaji et al (2006)	3	1	2006	Y	100	64.6	Hospital Inpatients	SCID	DSMIV MDD	39%	Japan
Kang et al (2012) [2weeks]	4	1	2012	Y	423	64.5	Hospital Inpatients	MINI International Neuropsychiatric Interview	DSMIIIR MDD +MnDD	42%	Korea
Kauhanen et al (1999)	4	3	1999	N	101	65.8	Hospital inpatients+outpatients	Psychiatric interview (unstructured)	DSMIIIR MDD +MnDD	43%	Finland
Kim et al (2000)	3	1	2000	Y	148	62	Hospital Outpatients	SCID	DSMIV MDD	36.50%	South Korea
Kulkantrakorn et al (2007)	4	1	2007	Y	75	65.4	Stroke rehabilitation unit in hospital	SCID	CISR criteria for ICD10	55%	Thailand
Laska et al (2007) [Aphasia]	2	3	2007	N	60	74	Hospital inpatients	Unstructured Clinical Interview	DSMIV MDD+MnD	44.90%	Sweden
Lee et al (2007)	3	1	2007	Y	200	71.95	Stroke rehabilitation unit in hospital	SCID	DSMIV MDD	36%	China
Lee et al (2008)	2	3	2008	N	253	72.2	Hospital inpatients	Unstructured Clinical Interview	DSMIV MDD	37.20%	Hong Kong
Leentjens (2006)	3	1	2006	NR	165	68.1	Hospital inpatients	SCID (DSM-IV)	DSMIV-R MDD	43.00%	Netherlands
Leppävuori et al (2003)	3	1	2003	Y	277	70.7	Community	Present State Examination	DSMIV MDD	49.10%	Finland
Lincoln et al (2003)	4	1	2003	N	143	66	Hospital Outpatients	SCAN (DSM-IIIR)	DSMIIIR MDD	49%	UK
Lipsey et al (1985)	2	2	1985	Y	48	63.5	Rehabilitation Hospital	Present State Examination	DSMIII MDD	63%	USA
MacHale et al (1998)	3	1	1998	Y	145	66	Hospital Outpatients	Standardised semistructured psychiatric interview	DSMIV MDD	48%	UK
Morris et al (1990)	4	1	1990	N	99	70.8	Rehab hosp	CIDI	DSMIII MDD+MnD	48%	Australia
Morris et al (1991)	3	1	1991	Y	76	71.3	Rehab hosp	CIDI	DSMIII MDD+MnD	47%	Australia
Morris et al (1992)	3	1	1992		88	70	Rehab hosp	CIDI	DSMIII MDD+MnD	45%	Australia
Morris et al (1994)	3	1	1994	Y	94	70.6	Rehab hosp	CIDI	DSMIII MDD+MnD	48%	Australia
Morris et al (1996)	2	2	1996	N	41	70	Hospital Inpatients	CIDI	DSMIIIR MDD	56%	Australia
Naarding et al (2002)	2	2	2002	Y	44	70.3	Neurological ward inpatients	SCID	DSMIV MDD	36.40%	Netherlands
Nagaraja et al (1997)	2	2	1997	Y	40	42.4	National Institute of Mental Health and Neuroscience (NIMHANS)	Comprehensive psychiatric rating scale (CPRS), HDRS	DSMIII-R	27.50%	India
Niedermaier et al (2004)	3	1	2004	Y	70	64.95	Stroke rehabilitation unit in hospital	Semi-structured interview	DSMIV MDD	32.86%	Germany
O'Rourke et al (1998)	3	1	1998	N	105	68	Hospital inpatients	SADS interview	DSMIV MDD	NR	UK
Palomäki et al (1999) [	2	2	1999	N	49	54.7	Hospital inpatients	SADS interview	DSMIIIR MDD	34.70%	Finland

Paolucci et al (2006)	3	4	2005	N	1064	67.2	Hospital Outpatients	Two Step Proceedure (BDI>10 then SCID)	DSMIV MDD+MnD	40%	Italy
Paradiso and Robinson (1998)	4	1	1998	Y	301	58.94	Hospital inpatients	Present State Examination	DSMIV MDD+MnD	43.50%	USA
Paradiso and Robinson (1999)	4	1	1999	Y	141	59.2	Hospital inpatients	Present State Examination	DSMIV MDD+MnD	40.60%	USA
Paradiso et al (1997) [	4	1	1997	Y	142	60.46	Hospital inpatients	Present State Examination	DSMIV MDD+MnD	44%	USA
Parikh et al (1988)	3	1	1988	Y	80	58	Hospital Outpatients	Present State Examination	DSMIII MDD+MnD	22.20%	US
Pohjasvaara et al (1998)	3	1	1998	Y	277	55-85	Hospital inpatients+outpatients	SCID	DSMIIIR MDD+MnD	NR	Finland
Quaranta et al (2008)	4	1	2008	Y	143	62.77	Inpatient rehabilitation unit	SCID	DSMIVTR MDD+MnD	43%	Italy
Rao et al (2001)	2	3	2001	Y	25	>65	Community	SCID	DSMIV MDD	NR	UK
Robinson et al (1983)	4	1	1983	Y	103	59	Hospital inpatients	Present State Examination	DSMIII MDD+MnD	39%	USA
Roger et al (2009)	3	1	2009	Y	67	71	Stroke rehabilitation unit inpatient hospital	SCID	DSMIV MDD+MnD	52.20%	USA
Rybarczyk et al (1996)	2	3	1996	N	50	71	Inpatient rehabilitation unit	Unstructured Clinical Interview	DSMIII MDD+MnD	NR	USA
Sachdev et al (2007)	2	2	2007	N	47	72.02	Community	SCID	DSMIV	42.60%	Australia
Sagen et al (2009)	4	1	2009	Y	104	64.5	Stroke unit in hospital	SCID	DSMIV MDD+MnD	41.30%	Norway
Santos et al (2009)	2	3	2009	Y	41	77.46	Hospital Outpatients	Unstructured Clinical Interview	DSMIV MDD	49%	Switzerland
Schramke et al (1998)	3	2	1998	N	44	64	Rehabilitation Hospital	SCID	DSMIIIR MDD +MnDD	34%	USA
Schubert et al (1992)	2	3	1992	Y	21	47-72	Rehab hosp	Psychiatric diagnostic interview	DSMIIIR MDD	52%	USA
Schultz et al (1997)	3	1	1997	Y	142			Psychiatric diagnostic interview	DSMIV	43%	US
Schwartz et al (1993)	3	1	1993	Y	91	66	Rehab hosp	Psychiatric diagnostic interview	DSMIII MDD	0%	USA
Sharpe et al (1990)	3	1	1990	N	60	71	Community	SCID	DSMIIIR MDD+MnD	38%	UK
Shinar et al (1986)	2	2	1986	Y	27	56	Outpatients/Inpatients	Present State Examination	DSMIII MDD+MnD	59.20%	Israel
Sivrioglu et al (2009)	3	3	2009	Y	85	59	Rehabilitation or stroke unit	Psychiatric interview (unstructured)	DSMIV MDD+MnD	62.30%	Turkey
Spalletta et al (2002)	4	1	2002	Y	153	66.26	Hospital Outpatients	SCID	DSMIV MDD+MnD	40%	Italy
Spalletta et al (2005)	4	1	2005	Y	200	65.6	Hospital inpatients	SCID	DSMIV MDD+MnD	41%	Italy

Srivastava et al (2010)	2	3	2010	Y	51	46.06	Neurological rehabilitation unit	Unstructured Clinical Interview	ICD10 criteria	24%	India
Starkstein et al (1987)	3	2	1987	Y	45	57.5	Hospital inpatients and rehab unit	Present State Examination	DSMIII MDD+MnD	35%	USA
Starkstein et al (1987)	3	2	1987	Y	45	58.4	Acute and rehabilitation	Present State Examination	DSMIII MDD	NR	US
Starkstein et al (1988)	3	1	1988	Y	79	60.05	Hospital inpatients	Present State Examination	DSMIII MDD+MnD	36%	USA
Starkstein et al (1992)	3	1	1992	Y	80	58.81	Hospital inpatients	Present State Examination	DSMIII MDD+MnD	NR	USA
Stone et al (2004)	2	2	2004	Y	35	72	Community / home	SCID	DSMIV MDD+MnD	32%	UK
Storer and Byrne (2006)	3	1	2006	Y	61	71.9	Stroke unit in hospital	SCID	DSMIV MDD	59%	Australia
Tang et al (2002)	4	1	2002	Y	157	71	Stroke rehabilitation unit in hospital	SCID	DSMIIIR MDD +MnDD	55%	China
Tang et al (2004a)	3	1	2004	Y	100	74	Rehabilitation Hospital	SCID	DSMIIIR Any depression (MDD, dysthymia, or adjustment disorder with depressed mood)	45%	Hong Kong
Tang et al (2004c)	3	1	2004	Y	60	71	Hospital inpatients	SCID	DSMIIIR MDD+MnDD+Dys	55%	Hong Kong
Tang et al (2005)	4	1	2005	Y	189	68.1	Hospital Outpatients	SCID	DSMIV MDD+MnD	40.70%	China
Tang et al (2011)	4	1	2011	Y	591	66	Stroke unit in hospital	SCID	DSMIV MDD+MnD	39.10%	China, Australia
Terroni et al (2009)	3	1	2009	Y	73	48.7	Neurological rehabilitation unit	SCID	DSMIV MDD	42.50%	Brazil
Terroni et al (2011)	4	1	2011	Y	68	51.03	Neurological rehabilitation unit	SCID	DSMIV MDD	47%	Brazil
Turner et al (2012)	3	1	2012	N	72	67	Hospital Outpatients	SCID	DSMIV MDD	47.20%	Australia
Van de Weg et al (1999)	3	1	1999	Y	85	61.4	Rehabilitation centre	SCID	DSMIII MDD	51%	Netherlands
Van Ginkel et al (2012)	3	1	2012	Y	164	71	Hospital inpatients	CIDI	DSMIV MDD	40.90%	Netherlands
Vataja et al (2001)	4	1	2001	Y	275	70.7	Community + Hospital	Present State Examination	DSMIV MDD+MnD	49.00%	Finland
Williams et al (2005)	3	1	2005	Y	316	59	Hospital Outpatients	SCID	DSMIV MDD	46%	USA
Yang et al (2010) [2weeks]	2	3	2010	Y	100	68.95	Neurology Dept	Unstructured Clinical Interview	DSM IV	51%	China
Zhang et al (2012)	3	2	2012	Y	163	18-80yrs (no mean)	Neurology Dept	SCID	DSMIV MD+MnD	NR	China
Zhou et al (2010)	2	3	2010	Y	93	62.6	Neurology Dept	Unstructured Clinical Interview	DSMIV	44%	China

Graphical abstract

Figure – Meta-regression on major depression and time since stroke



Highlights

We conducted a meta-analysis of 128 studies involving 15,573 patients follow a stroke.

The point prevalence of major depression was 17.7% (95% CI = 15.6% to 20.0%).

Any form of depression (ADD) was present in 33.5% (95% CI = 30.3% to 36.8%).

Risk of depression was higher after left hemisphere stroke, aphasia, and past history of mood disorders.

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